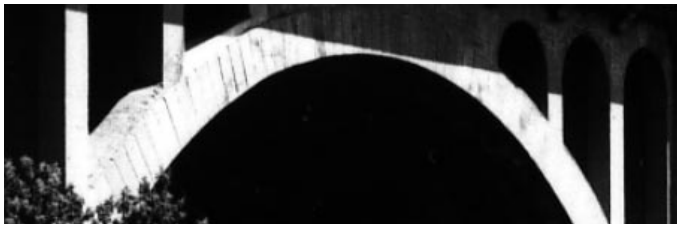
Statement of the Director



This document is the fourth *Transportation Statistics Annual Report* (TSAR) prepared by the Bureau of Transportation Statistics (BTS) for the President and Congress. As in previous years, it reports on the state of U.S. transportation system at two levels. First, in Part I, it provides a statistical and interpretive survey of the system—its physical characteristics, its economic attributes, aspects of its use and performance, and the scale and severity of unintended consequences of transportation, such as fatalities and injuries, oil import dependency, and environment impacts. Part I also explores the state of transportation statistics, and new needs of the rapidly changing world of transportation.

Second, Part II of the report, as in prior years, explores in detail the performance of the U.S. transportation system from the perspective of desired social outcomes or strategic goals. This year, the performance aspect of transportation chosen for thematic treatment is "Mobility and Access," which complements past TSAR theme sections on "The Economic Performance of Transportation" (1995) and "Transportation and the Environment" (1996).

Mobility and access are at the heart of the transportation system's performance from the user's perspective. In what ways and to what extent does the geographic freedom provided by transportation enhance personal fulfillment of the nation's residents and contribute to economic advancement of people and businesses?

This broad question underlies many of the topics examined in Part II: What is the current level of personal mobility in the United States, and how does it vary by sex, age, income level, urban or rural location, and over time? What factors explain variations? Has transportation helped improve people's access to work, shopping, recreational facilities, and medical services, and in what ways and in what locations? How have barriers, such as age, disabilities, or lack of an automobile, affected these accessibility patterns? How are commodity flows and transportation services responding to global competition, deregulation, economic restructuring, and new information technologies? How do U.S. patterns of personal mobility and freight movement compare with other advanced industrialized countries, formerly centrally planned economies, and major newly industrializing countries? Finally, how is the rapid adoption of new information technologies influencing the patterns of transportation demand and the supply of new transportation services? Indeed, how are information technologies affecting the nature and organization of transportation services used by individuals and firms?

PART I: THE STATE OF THE TRANSPORTATION SYSTEM

Extent, Condition, and Performance of the System

The United States has the world's most extensive transportation system, serving the 265 million people and 6 million business establishments that occupy the fourth largest country by land area. (Table 1-1 in chapter 1 provides a detailed summary by mode.)

Use of the transportation system grew rapidly between 1970 and 1995. Passenger-miles traveled (pmt) grew 95 percent, at an annual rate of 2.7 percent, while intercity freight activity measured in ton-miles increased by 65 percent. Average pmt increased during this time from 11,000 to 16,500 miles per person (excluding miles traveled by heavy trucks). Air activity grew at the fastest rates, while, in absolute terms, the highway modes accounted for the largest increases in miles traveled and ton-miles.

Highway and bridge conditions have generally improved in recent years. Although new measurement techniques complicate trend analysis, recent data published by the Federal Highway Administration (FHWA) suggest improvement in roads between 1994 and 1995. Congestion in many metropolitan areas has worsened. As for air passenger service, on-time arrivals for major carriers declined between 1994 and 1995. The freight rail industry is showing improved physical condition, despite less track and increased traffic and revenue. By contrast, Amtrak, the nation's passenger rail carrier, has experienced a fall in patronage. While the average age of its locomotives has declined, the average age of its passenger car fleet has increased. Capital expenditures in public ports were about 5 percent higher in 1994 than in 1993 (not including a major land purchase in 1994). There is little public information available to allow tracking of the performance and condition of pipelines.

Although the analysis in chapter 1 covers all modes, urban transit is given more detailed treatment in this year's report. The condition of urban transit equipment showed a mixed picture between 1985 to 1995. Although the fleet of large and mid-size buses has become older, many smaller buses were added for paratransit services over the past few years, stabilizing the age of the total fleet. Rail transit, power systems, stations, bridges and tunnels, and maintenance improved between 1984 and 1992. The average age of light-rail transit vehicles declined somewhat

between 1985 and 1995, but the average age of heavy-rail vehicles increased. The age of commuter railcars also increased: for example, powered cars averaged 12.3 years in age in 1985 and 19.8 years in age in 1995.

Over the 1985 to 1995 period, the number of cities served by rail transit increased and there was continued expansion of bus service into outlying suburban areas of large metropolitan regions and into smaller urbanized areas. Rail transit service frequency increased. By contrast, bus service frequency declined with the expansion of systems into outlying suburbs and smaller urban areas.

Despite expansion of service, urban transit pmt was about the same in 1995 as in 1985, and ridership declined by about 11 percent. This decline masks a complex pattern of transit patronage. There has been growth in newer heavy-rail, light-rail, and commuter rail systems and level or declining patronage in older rail systems and buses. Some of the growth in ridership on newer rail systems has been at the expense of bus ridership.

The occasion of an annual report offers an opportunity to review a few key events that either caused major dislocations in transportation or highlight important features of the transportation system. The report discusses three 1996 events: a blizzard in the eastern United States at the beginning of the year; another blizzard in the Northwest at the end of the year; and the provision of transportation for the Atlanta Olympic Games.

The two snowstorms made travel very difficult for several days, pointing out the vulnerability of the transportation system to extreme weather events. The disruption also focused public attention on the importance of the transportation system, which many people take for granted when operations are troublefree. As for the Olympic Games, the expanded transportation system put in place by various public agencies at all levels was considered a success. Over the 17 days of the event, the transportation system moved approximately 18 million passengers, twice its normal load.

Transportation and the Economy

Although transportation touches every facet of our economic life, current economic indicators do not fully capture the rich interplay between transportation and the larger economy, or fully measure the ways transportation supports economic activity. A number of indicators are discussed below, such as the share of transportation-related final demand in gross domestic product (GDP),[1] household and government expenditures, returns on public investment, and transportation-related employment, in an attempt to describe these economic relationships.

Transportation-related final demand as a share of GDP has remained slightly under 11 percent since 1989, contributing $777 billion to a $7.25 trillion GDP in 1995. Transportation-related final demand is the broadest measure of transportation's economic importance, as it includes the value of outputs from many non-transportation industries (e.g., cars produced by the automobile industry and gasoline produced by the petroleum industry).

A narrower measure is the value-added by the for-hire transportation industry, defined here as those establishments that provide transportation services to the public for a fee. The share of GDP of the for-hire transportation industry was $223 billion in 1994, or about 3.2 percent of total GDP in current dollars. This does not include the value of in-house transportation services taking

[1] Transportation-related final demand is defined as the value of all transportation-related goods and services (regardless of industry of origin) delivered to the final customer; this includes consumer and government expenditures, investments, and net exports.

place within firms that are not primarily engaged in providing transportation services to the public (e.g., a manufacturing plant or a grocery store chain). Although in-house providers of transportation are very important, current information is insufficient to estimate their contribution. BTS and the Bureau of Economic Analysis of the U.S. Department of Commerce are conducting a joint project, called the Transportation Satellite Account, to develop a more complete picture of the transportation industry, including in-house transportation services.

Household and government expenditures also indicate transportation's economic importance. Transportation's share of household expenditures was 19 percent in 1994. The largest share of household expenditures was housing, followed by transportation, and then food. Household expenditures on transportation vary significantly by income. In 1994, transportation's share of household expenditures ranged from 14.1 percent for the $5,000 to $10,000 income category to 22.1 percent for those in the $40,000 to $50,000 income category.

Total government expenditures for transportation were $116 billion in 1993. State and local governments contribute the lion's share of public expenditures for transportation. From 1983 to 1993, their share (excluding federal grants) rose by 38 percent in real terms; federal spending on transportation during that period only increased by 15 percent, resulting in a decline in the federal share of government transportation expenditures from 37 to 32 percent. In 1993, about 60 percent of government expenditures were for highways, followed by transit (19 percent), air (15 percent), and water transportation (5 percent). Rail and pipelines together accounted for less than 1 percent.

In 1993, government revenues from gasoline taxes and other transportation-related taxes and fees totaled $85 billion, and covered 73 percent of government transportation expenditures. State governments collected about half of these revenues, the federal government about one-third, and local governments about one-fifth. By mode, highways generated about 70 percent of these revenues, followed by air (15 percent), transit (10 percent), and water transportation (4 percent).

From 1977 to 1994, federal transportation-related budget receipts, including revenue from trust funds (taxes and user fees dedicated to a specific mode), rose from $16 billion to $19.7 billion (in constant 1987 dollars). The two largest sources are the Highway Trust Fund (HTF)—which has highway and transit accounts—and the Airport and Airway Trust Fund. Of these, the aviation trust fund revenues increased the most, while HTF transit account revenues grew more slowly and HTF highway account revenues declined slightly. Together, the trust fund balances (unspent money in these accounts at the end of the year) grew substantially from the mid-1980s to the early 1990s, but have declined from the 1992 high point.

In 1993, governments at all levels invested $52.5 billion in transportation infrastructure and equipment. Most of the investment was for highways, followed by airports and transit.

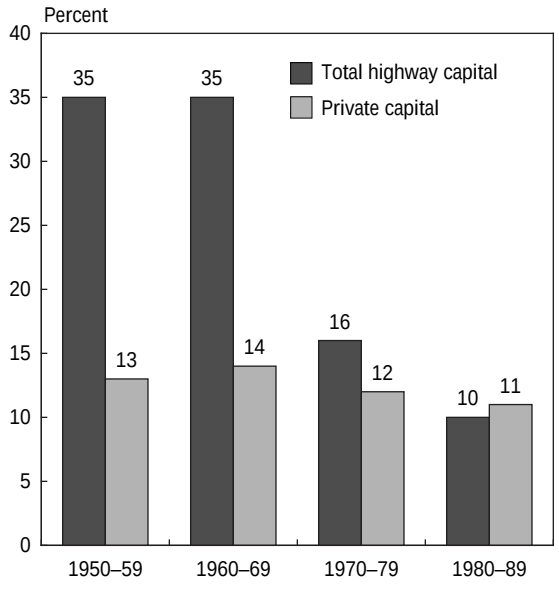
In recent years, a good deal of research has been devoted to assessing the economic returns from government investment in public infrastructure, including transportation infrastructure.[2] A recent study prepared for FHWA by Nadiri and Mamuneas offers strong evidence on the many ways highway capital in the United States contributes to the productivity of 35 different industries and the overall economy. In particular, it suggests that in the first two decades or more while the Interstate highway network was expanding the overall economic benefits were high—with the return on the investment of a dol-

[2] See *Transportation Statistics Annual Report 1995* for an indepth discussion of public investment in transportation.

lar in highway infrastructure greater than the return on a dollar of private capital investment. As the Interstate Highway System neared completion in the 1980s, the rate of return on highways fell gradually to just under the return on private capital investment in the economy.

Transportation is also a major source of employment. Employment in the for-hire transportation industry (3.9 million people) could be added to employment in transportation occupations within nontransportation industries to estimate the number of people employed in transportation functions. The resulting figure of 5.8 million employees, however, is a low-end estimate. For example, it excludes people who are not in transportation occupations who nonetheless work full time in transportation activities in nontransportation industries. Nor does it include most employees in such transportation-related functions as transportation equipment manufacture or in government. If all of these jobs are counted, employment in transportation and related industries has fluctuated around 9.9 million since 1990.

Annual Rate of Return by Type of Investment



SOURCE: M.I. Nadiri and T.P. Mamuenas. 1996. Contribution of Highway Capital to Industry and National Productivity Growth, prepared for the U.S. Department of Transportation, Federal Highway Administration, Office of Policy Development. September.

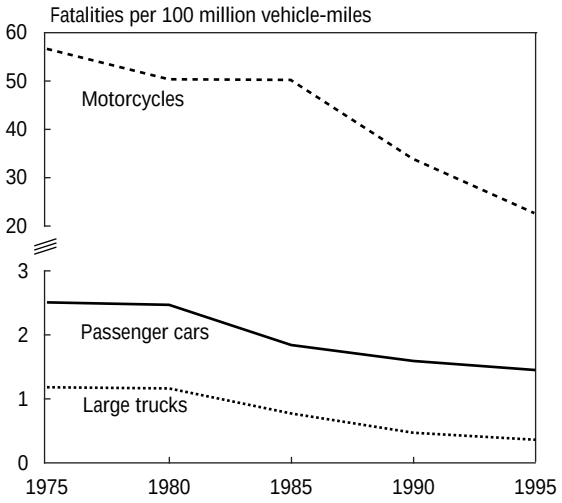
Transportation and Safety

In the United States, transportation has accounted for roughly half of accidental deaths for many years. Transportation fatality trends show that commercial airlines, buses, and railroads are the safer passenger modes. Travel by private vehicle—whether a car or light truck, a recreational boat, or personal use aircraft—is less safe. In 1995, more people died in recreational boating and general aviation crashes than were killed as passengers on trains, buses, or planes in commercial aviation combined.

Crashes involving motor vehicles accounted for 41,798 fatalities in 1995—some 94 percent of the transportation deaths that year. An estimated 3.5 million people were injured in crashes involving motor vehicles. Motor vehicle crashes are the leading cause of death for Americans until their mid-thirties, except for the very youngest children. The National Highway Traffic Safety Administration (NHTSA) estimates that the costs to the economy over the lifetimes of those injured or killed in motor vehicle crashes in 1994 will be $150.5 billion. This amount does not attempt to estimate the dollar value of the loss of quality of life.

Despite the huge toll—115 people died and over 9,500 people were injured in highway crashes each day in 1995—remarkable improvement in highway safety has occurred in the last three decades. The greatest number of deaths occurred in 1972, when 54,589 people were killed in crashes involving motor vehicles. Had the 1969 death rate of 5.0 fatalities for every 100 million vehicle-miles traveled (vmt) persisted, more than 120,000 people would have died from motor vehicle crashes in 1995, compared with the actual figure of 41,798 fatalities (about

Occupant Fatalities



SOURCE: See figure 3-1 in chapter 3.

1.7 fatalities for each 100 million vmt). The improvement was evident in most categories of vehicles, even though the rates vary greatly. Many factors, including installation and use of safety innovations, better highway design, safety standards and regulations, education efforts, and improved emergency and medical care, have helped reduce the fatality rate.

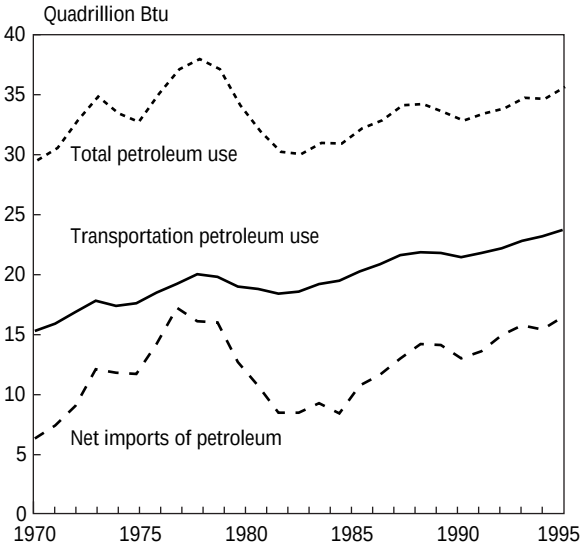
Since 1992, however, the fatality rate has been stable, portending an increase in the number of fatalities if vmt continues to increase. Many fatalities could be avoided if more drivers, occupants, and pedestrians followed well-known safety precautions. In 1995, 17,274 people died in alcohol-related crashes—41 percent of all people killed in highway crashes. Excessive speed or driving too fast for conditions was a contributing factor in 31 percent of fatal crashes. (Often, fatal crashes involve speeding and drinking). While safety belt use has increased over the years, nearly one-third of passengers still do not buckle up. NHTSA estimates that there would be 9,835 fewer fatalities if everyone used safety restraints.

Although they involve far fewer fatalities in total than private vehicles, fatal crashes involving commercial vehicles—especially airplanes, trains, and buses—receive great scrutiny from safety organizations, the press, and the public, in part because a single crash can involve dozens or, in some cases, hundreds of deaths. Two plane crashes in 1996—the crash of ValuJet Flight 592 into the Florida Everglades and the crash of TWA Flight 800 off Long Island Sound—have been the subject of extensive investigation by safety authorities, and received prime time coverage from the media for many weeks, putting a spotlight on aviation safety. With air travel growing in popularity, aviation safety will continue to be a prominent concern of the traveling public.

Travel by commercial airline is much safer today than it was three decades ago, when about 10 people died for every 100,000 plane departures on U.S. air carriers. Since 1992, the rate has fluctuated between 1 and 2 fatalities per 100,000 departures. (Because crashes are infrequent, this rate is expressed as a 5-year moving average to even out large year-to-year variations.) The most robust improvement (as shown in the moving average) occurred in the 1960s and the 1970s; since then, the improvement has slowed.

Safety data are collected separately for each individual mode. There is, however, increasing interest in examining safety trends on a cross-modal or systemwide basis. This year's safety chapter addresses four cross-modal issues: the safety of children in the transportation system; safety of workers in transportation occupations or occupations that require frequent use of transportation; transportation of hazardous materials; and efforts to develop common measures of safety across the modes.

U.S. Petroleum Use and Imports



SOURCE: See figure 4-7 in chapter 4.

Energy and the Environment

For nearly half a century, transportation has accounted for about one-quarter of total U.S. energy use. Between 1994 and 1995, transportation energy use grew by 1.7 percent—a rate of growth similar to that which has occurred since 1985. In contrast, transportation energy use grew by only 0.6 percent annually between 1973 and 1985, when oil supply shocks and higher prices dampened demand and inspired major improvements in energy efficiency.

Petroleum-based fuels are used to satisfy almost all (95 to 97 percent) of U.S. transportation energy demand. Transportation accounts for about two-thirds of the nation's demand for oil. Despite recent gains in the number of alternative fuel vehicles and the greatly increased use of alcohols and ethers in gasoline to satisfy mandated cleaner fuel requirements, nonpetroleum fuels still supply a small share.

Approximately half of the petroleum consumed in the United States must be imported. Petroleum dependence is of concern because the world's oil reserves are increasingly concentrated in relatively few countries. The Organization of Petroleum Exporting Countries (OPEC) holds two-thirds to three-quarters of the world's proven reserves and more than half of the world's estimated resources. In the past three years, however, increased production in the North Sea and other nontraditional producing areas stabilized the market influence of OPEC and kept prices low. As these relatively small reserves are depleted, OPEC market share and influence likely will grow. World dependence on OPEC oil is expected to rise from today's 40 percent to 52 percent in 2010 and 56 percent by 2015, levels similar to those of the early 1970s.

Concentration of production can lead to price volatility and upward pressure on prices, even if no supply disruption occurs. The potential for volatility in petroleum markets was illustrated in the spring of 1996, when a confluence of factors, including higher crude prices, low inventories, and a surge in demand, caused a greater than normal seasonal increase in gasoline prices. Average gasoline prices rose almost 22¢ per gallon, in contrast to a typical seasonal increase of 5¢ per gallon. This jump renewed public concern about the operation of petroleum markets and the nation's dependence on petroleum.

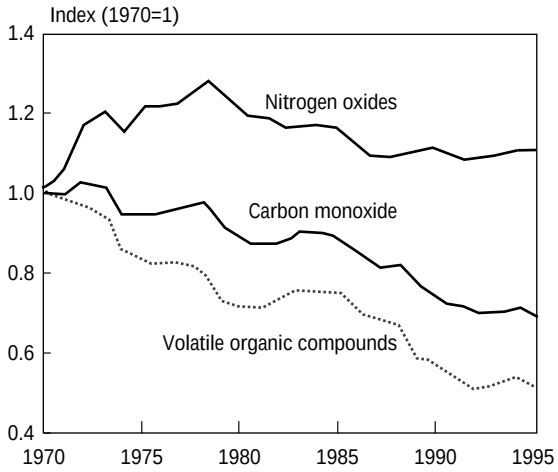
It appears that the transportation sector has reached the end of a 20-year period of steadily improving energy efficiency. Although some modes, such as air passenger travel and rail freight, continue to show efficiency gains, this is offset by a decline in the energy efficiency of highway travel. (Accounting for the vast majority of all passenger-miles, the highway mode dominates U.S. passenger travel and energy use trends.) Bus and rail transit modes also showed higher energy intensity.

BTS's analysis shows that cumulative energy savings from changes in transportation energy efficiency declined between 1993 and 1994—the

first time since 1985. Average miles per gallon of light-duty vehicles, now 24.6, has not changed significantly since 1979. Technological improvements were largely offset by increasing vehicle weight and power and decreasing vehicle occupancy rates.

The energy efficiency of air travel has continued an unbroken 22-year trend of improvement. The biggest factor was an increase in load, but improved aircraft efficiency accounted for about one-third of the improvement. Like air travel, rail freight energy efficiency has made steady gains for two decades. Many factors have contributed to efficiency gains, including improved operating practices that have greatly reduced engine idling and improved train pacing, lighter weight cars, and new locomotive technologies.

Selected Air Emissions from Transportation



NOTE: Transportation emissions include all onroad mobile sources and the following nonroad mobile sources: recreational vehicles, recreational marine vessels, airport service equipment, aircraft, marine vessels, and railroads.

SOURCE: See figure 4-10 in chapter 4.

► Environmental Impacts

Because of its enormous size and activity, the U.S. transportation system inevitably has undesirable environmental impacts.[3] Air pollution is the most studied environmental impact and has been the subject of extensive remedial action, air quality monitoring, and data collection. Transportation accounts for two-thirds of carbon monoxide (CO), 42 percent of nitrogen oxides, and nearly one-third of the hydrocarbons produced.

Despite a doubling in highway vehicle-miles, most highway vehicle emissions are far lower today than in 1970, reflecting emissions controls adopted under federal clean air requirements. The record of success has not been uniform, however. There were increases in some transportation emissions in 1992, 1993, and 1994 compared with previous years. According to the latest U.S. Environmental Protection Agency estimates, progress was made in 1995, with, among other things, a major reduction in CO emissions and the first drop since 1992 in volatile organic compounds emissions. Reductions in onroad vehicle emissions accounted for the lion's share of the recent reductions; emissions from aircraft and airport services vehicles also decreased. (Lead emissions from transportation have been all but eliminated for several years.)

Transportation-related greenhouse gas emissions continue to follow trends prevalent over the past several years. Carbon dioxide emissions by transportation continue to rise due to increased energy use. Since 1990, transportation has accounted for nearly 40 percent of the national increase in carbon dioxide emissions from end-use sectors, with potentially serious implications for global climate change.

Strides have been made in understanding, quantifying, and reducing some other environmental impacts of transportation. For example, federal noise standards have reduced exposure to unacceptable levels of aircraft noise, and the government continues to monitor underground storage tank releases and cleanup efforts. Other impacts, such as land use and habitat fragmenta-

[3] See Part II of *Transportation Statistics Annual Report 1996* for a comprehensive discussion of transportation-related environmental issues.

tion, are less well understood, and thus more difficult to assess or quantify.

The State of Transportation Statistics

When Congress, through the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), created the Bureau of Transportation Statistics, the purpose was to enhance the transportation knowledge base and to inform the public about transportation and its consequences. To that end, Congress called on BTS to document the methods used to obtain information and to ensure the quality of statistics used in this annual report, and to include in the report "recommendations for improving transportation statistical information." Because ISTEA's authorization for federal spending ends with fiscal year 1997, Congress is now evaluating alternative authorization options for these programs in the future. Thus, this 1997 annual report comes at an opportune time to review the path followed by BTS and other information-producing agencies, and examine whether that path is appropriate for the start of the next century. Chapter 5, summarized below, discusses progress and challenges in meeting ISTEA information needs, suggests ways in which the world of information may change, and indicates some future directions that decision-makers might consider for transportation statistics programs.

BTS has taken many actions to fill data and knowledge gaps and needs identified in the ISTEA. Among other things, the Bureau has:

- published four transportation statistics annual reports, as well as annual compendiums of national transportation statistics;
- completed national surveys of commodity and passenger flows by all modes and intermodal combinations;
- initiated efforts with Canada and Mexico to produce a continental view of North American transportation;
- established a standard classification of transportable goods;
- become a leader in developing geographic information systems databases; and
- actively disseminated information, using printed and newer electronic means.

The ISTEA provided a good start toward meeting critical information needs, but several topics remain for which more or better information are needed. These include: 1) domestic transportation of international trade; 2) timeliness and reliability of transit, highway travel, and freight modes; 3) costs of transportation services; 4) more reliable information on the number of motor vehicles by vehicle class, and distances they are driven; 5) fuller information on the location, connectivity, capacity, and condition of railroad lines; and 6) interactions among transportation, economic development, and land use.

Needs for information and technologies for meeting these needs continue to evolve rapidly. Statistics on cost and service quality, involving timeliness and reliability, and not just forecasts of traffic volume and capacity are needed. Involvement by metropolitan planning organizations, private sector interests, and citizen organizations, as well as federal and state agencies, has increased the number and range of customers demanding data and the tools to use the data.

The Government Performance and Results Act of 1993 (GPRA) is also affecting the need for statistical information. GPRA requires all federal agencies to begin measuring their outcomes, and not just their inputs and outputs. GPRA is to be the basis of budget decisions by the Office of Management and Budget and will be monitored by Congress. GPRA's focus is prompting many agencies to become aware of the conditions being measured by BTS and other statistical agencies. Most state departments of transportation and some local agencies also are undertaking performance measurement efforts.

Decentralization of decisionmaking, either from the public sector to the private sector through deregulation or from the federal government to state and local governments, is potentially the biggest change in transportation policy to be informed by statistics. Although decentralization could reduce the federal role in many areas, the need for publicly available transportation statistics may grow. The free flow of information is often a prerequisite to properly functioning private markets, and state and local officials need to relate conditions within their jurisdictions to national and international trends.

In response to customer demands, BTS proposes to build on its initial products and services with three major initiatives. These initiatives are part of the Administration's proposed National Economic Crossroads Transportation Efficiency Act (NEXTEA). They include: expanded programs of data collection, and the development of a knowledge base involving international transportation in a globalized economy; expanded services and grants to state, local, and private decisionmakers to enhance data collection and sharing throughout the transportation community; and a program of research, technical assistance, and data-quality enhancement to improve performance measurement. These proposals are discussed in detail in chapter 5.

PART II: MOBILITY AND ACCESS

Part II explores mobility's importance in the American society and economy, and the transportation system's facilitating role in providing access to opportunities. Mobility, as used here, refers to the *potential for movement*. It expands the geographic choices available to people and businesses. Today's level of personal mobility (as reflected in miles traveled per capita) is unparalleled in U.S. history. Mobility can enhance the ability of people to participate in economic and social life, expanding personal freedom and choice. Mobility helps businesses serve new markets, provides more choices for locating facilities, broadens their range of suppliers, and increases the available pool of workers.

Accessibility refers to the *potential for spatial interaction with various desired social and economic opportunities.* Accessibility varies for individuals and across regions. Part II describes such variations in accessibility in the context of barriers to movement, such as age, location, disbility, and the lack of availability of vehicles or transportation services.

Part II also examines advances in information technologies (IT), and their ramifications for transportation. Transportation firms and their customers are adopting a number of generic information technologies made possible by advances in telecommunications and computers. IT is transforming the way these firms do business in a manner reminiscent of the change wrought on transportation and the broader economy in the 19th century by the telegraph and the railroad. This IT transformation is discussed in terms of changes in the nature of transportation demand and the supply of new transportation services, and in the emerging pattern of activities, management structures, and competition both among transportation producers and among their customers.

Part II discusses six topics:

- concepts of mobility and access,
- personal mobility in the United States,
- access to opportunity,
- freight,
- the international context, and
- mobility and access in the information age.

Concepts of Mobility and Accessibility

Mobility is measured by the movement of people and materials on the transportation system. Accessibility is measured by the ease of reaching the location of a desired activity from another place.

Measurements of mobility and accessibility can be helpful in evaluating the performance of transportation. A number of methodological difficulties, however, limit their use. Of the two concepts, accessibility is the more difficult to measure, but measuring mobility is not especially easy. Because of data gaps, there is often little alternative to using indirect measures.

Analysts have employed the concept of *revealed mobility* (defined as the number of miles traveled or trips taken over some unit of time such as a day, week, or a year) as an imperfect proxy for mobility. The assumption in using revealed mobility is that, all else being equal, people taking many trips or traveling many miles have a higher level of mobility. This assumption is not always borne out, however. For example, revealed mobility data would register a mobility decline if a commuter moves to a residence closer to work. Yet, having to travel fewer miles to work or spend less time commuting is not in any meaningful sense a decline in mobility. Despite such problems, revealed mobility can be a useful analytical tool, and helps explain a great deal about travel behavior and shipping activities.

Accessibility measures can be useful in evaluating transportation access to locations where desired activities (e.g., employment, shopping, health care, and recreation) take place. They also can help identify access problems of people with limited transportation options. Several accessibility measures have been developed, including *relative accessibility* (measuring one location relative to another) and *integral accessibility* (integrating information about locations of several activities). Accessibility also encompasses a time element. While there may be several shops located a short distance from a person's home, they will not be accessible if they close for business before the person can get there from work, or do not open until after the commuter leaves home.

The concept of accessibility applies to firms as well. Manufacturing firms benefit if their suppliers and markets for their products are easily accessible, and if a large pool of workers is within commuting range. Retail stores and other service firms have an advantage if their location is highly accessible to a large number of potential customers. Firms that produce or use bulky materials need access to low cost transportation (e.g., railroads or waterways). If transportation time is more critical than cost, proximity to an airport may be needed for accessibility.

On a broad scale, accessibility can critically affect the economic prospects of entire regions. In the 19th century, Chicago's location as the main hub of a network of railroads gave it unmatched accessibility among midwestern cities. More recently, accessibility to Pacific Rim markets has been an impetus to growth in west coast port cities.

Measurement of accessibility requires information not only about travel but about the location of destinations. This task has become more complicated, reflecting multiple locations of facilities and activities in most urban regions. While once travel time to the central business district from a residential area may have sufficed as an indication of relative accessibility, today, relative accessibility measures might include average travel time or cost to the nearest shopping mall, hospital, or park.

Because of the variety of opportunities available in most urban areas, integral accessibility measures provide a better picture of the ability to reach many desired destinations. These measures are harder to construct, however, as they must combine information about many routes and destinations.

Developing appropriate accessibility indicators at different geographic scales is an important challenge. It is possible to develop accessibility measures for a zone or region—by

taking an average of a number of points within a zone. It is also possible to map patterns on a broader geographic scale by calculating accessibility at different points.

Personal Mobility in the United States

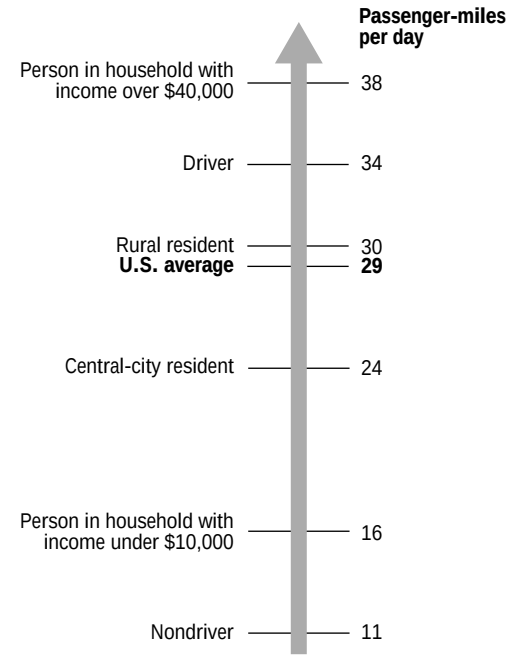
Americans travel more than ever, and continue to increase their use of the transportation system. Growth in passenger travel reflects many different factors, including population and labor force growth, a decline in household size, income growth, and dispersion of development and employment centers within metropolitan areas.

Four Nationwide Personal Transportation Surveys (NPTS) conducted between 1969 and 1990 provide detailed information about travel behavior of specific groups. (Results from the 1995 NPTS and BTS's American Travel Survey (ATS), also conducted in 1995, are not yet available. The ATS focuses on travel of more than 75 miles from home, while NPTS emphasizes daily trips.)

On average, most groups—men and women, young and old, rich and poor, city and rural residents—traveled more each day in 1990 than in 1969. Pronounced differences abound, reflecting both travel needs and the ability to travel. For example, suburban residents travel about 32 miles per day, slightly more than rural residents, and 30 percent more than central-city residents (just over 24 miles per day). People with higher incomes travel farther than those with lower incomes. People in the 40- to 49-year-old age group travel more than their younger or older age cohorts. Men travel further than women, on average, although women make slightly more daily trips. Whites travel further than blacks or Hispanics.

The availability of a passenger car or vehicle makes a critical difference. People relied on cars and other privately owned vehicles for 87 percent of their daily trips in 1990. Transit accounted for 2 percent of trips. All other modes (including airplanes, Amtrak, taxi, walking, bicycling, and school buses) accounted for the remaining 11 percent.

Average Daily Miles of Travel



SOURCE: See figure 7-1 in chapter 7.

The number of households without a car or other passenger vehicle declined from 21 percent in 1960 to 11.5 percent in 1990; still, 10.6 million households did not have a car in 1990. The ability to drive a passenger car has had an enormous impact on mobility. In 1990, people with drivers licenses took nearly twice as many daily trips, traveled three times as far, and took longer trips than people without licenses.

More than one-third of the travel by the average person involved social and recreational purposes; another third involved family and personal business (e.g., shopping and doctor's appointments). About one-quarter of the travel miles and 22 percent of trips are to and from the workplace. Work trips, however, are more important than the figure suggests. Many people shop and conduct other personal business during their commute to and from work. If such trip chaining

is added to simple work trips, then people structure 30 percent of their daily trips around their work schedule. While trip chaining during the work commute increases peak hour travel, it also may allow people to choose to make fewer trips and to travel fewer miles overall.

Access to Opportunities

On a nationwide basis, access has increased since the end of World War II reflecting the effects of further urbanization, the development of transportation facilities (particularly the completion of the Interstate Highway System and the expansion of the air transportation industry), and economic development. Despite these improvements, some areas of the country, experienced a decline in some types of transportation services. Fewer places are served today by passenger rail and intercity buses, in part because carriers have given up unprofitable or sparsely used services. Rural areas have been especially affected by such changes.

In urban areas, access has generally increased, although much of that access depends on the automobile. Transit service, too, is accessible to many urban residents. In 1990, half of the households in urban areas were located within one-quarter mile of a transit route, close enough for most people to walk. Transit, however, has had a hard time keeping up with the changing spatial distribution of opportunities, particularly job sites. Many poor people in central cities have very limited access to employment opportunities in the distant suburbs, the location of much new employment growth, including entry-level jobs. Insufficient transportation options are part of the explanation, as many urban poor people do not have cars and public transit stops are often lacking near suburban job locations. This will present a transportation challenge for many welfare recipients in central-city areas who will soon need employment due to changes in federal and state welfare programs.

Access to transportation is increasing for persons with disabilities, although challenges remain. Under the Americans with Disabilities Act of 1990, fixed-route service is to be made increasingly available to the disabled, with paratransit the recourse when fixed-route transit does not meet a customer's needs or is inappropriate to the situation. Paratransit accounted for 37 million trips in 1995. The evolving relationship between fixed-route transit and paratransit has several implications. For example, fixed-route service needs to be designed so as to be accessible to persons with disabilities (e.g., lifts on buses, and elevators and raised platforms at key train stations), and drivers need training on proper use of equipment. Fixed-route and paratransit services will now need to be coordinated and developed together, taking advantage of newly available information technologies. With greater accessibility, transit demand by the disabled has increased and will likely increase in the near future.

Mobility from the Freight Perspective

Because of the widespread availability of transportation and advances in information technologies, U.S. businesses are able to transport raw materials, finished goods, and people quickly, cheaply, and reliably, often across great distances. On a typical day in 1993, about 33 million tons of commodities, valued at about $17 billion, moved an average distance of nearly 300 miles on the U.S. transportation network. These estimates are based on data from the Commodity Flow Survey (CFS),[4] the most extensive survey of domestic freight movements undertaken since 1977, and supplemental data on waterborne and pipeline shipments. Even this large figure underestimates total freight movements,

[4] BTS calculated the daily total from final CFS data plus additional data on waterborne and pipeline shipments not fully covered by the CFS.

as it does not include most imports and some other flows.

In 1993, domestic establishments in the sectors covered by the CFS shipped materials and finished goods weighing 12.2 billion tons, generating 3.6 trillion ton-miles within the United States. The goods shipped were valued at more than $6.1 trillion. The food and kindred products sector accounted for the highest dollar amount of shipments identified in 1993, followed by transportation equipment. The major commodities by weight were petroleum and coal products, nonmetallic minerals, and coal. Food and kindred products ranked fourth by weight.

The major commodities vary greatly when ranked by the value per ton of shipment. On average in 1993, high-value commodities (e.g., worth over $5,000 per ton) accounted for 41 percent of the total shipments but only 2 percent of the tons and 5 percent of the ton-miles. Low-value commodity categories (e.g., those that averaged less than $1,000 per ton) accounted for less than half of the value, yet accounted for most of the tons and ton-miles, 96 percent and 91 percent, respectively.

A large portion of the shipments by value originate in states with a major manufacturing base, such as California, New York, Michigan, Texas and Illinois. These states were also the destinations for a large portion of shipments. Manufacturing, however, is an important activity in most states. Partly because firms are able to cheaply and reliably transport materials, parts, and merchandise from one part of the country to another, industrial production is dispersed throughout the United States.

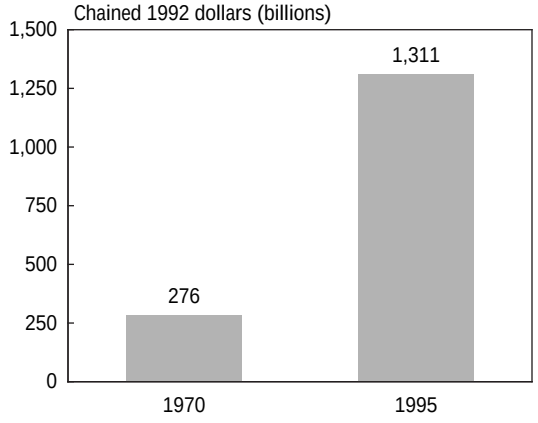
Raw materials and processed goods are shipped to all parts of the nation. For example, enormous amounts of farm products travel from north to south on the Mississippi River for export from Gulf coast ports. During the past three decades, the pattern of coal movement has significantly changed. Before the 1970s, about 95 percent of domestically produced coal was mined east of the Mississippi River. By 1995, more than 47 percent of U.S. coal was produced in the western states. This growth is partly due to increased demand for low-sulfur coal mined in Montana and Wyoming.

Trucking was the most dominant mode for freight transportation in 1993, moving about 72 percent by value and 53 percent by weight of shipments, and producing 24 percent of ton-miles. Rail freight produced slightly more ton-miles, 26 percent of the total, and accounted for 13 percent of the weight of shipments but just 4 percent of the value. Waterborne transportation accounted for over 17 percent of tons and 24 percent of ton-miles. The classic intermodal combination of truck and rail moved over 40 million tons of commodities worth over $83 billion. Parcel, postal, and courier services were used to move over 9 percent of the value of shipments valued at over $560 billion.

The distribution of freight carried by the different modes in part reflects changes occurring in the economy. Today, high value-adding businesses often require quick, reliable, and high-quality transportation to assure faster product deliveries, on time, with little product loss or damage. For example, parcel, postal, and courier services were used to transport nearly one-quarter of the shipments of electrical equipment, machinery, and supplies in 1993. Business uses of more expensive truck and air transport fit a pattern of dynamic, globalized economic activity moving toward lower overall costs of production and product distribution.

The transportation system also is used to provide other essential services to the economy. About 16 million households moved in 1994. Over 200 million tons of solid waste were collected by municipalities for recycling, incineration, or disposal in 1994. Most was transported

Sum of Imports and Exports of Goods



SOURCE: See figure 9-10 in chapter 9.

a few miles, but some was shipped as much as 2,000 miles for disposal.

The nation's transportation network facilitates an interconnected economy both nationally and internationally. Imports and exports of goods and services have grown rapidly. Since 1970, international waterborne freight moving to and from U.S. ports has nearly doubled by weight. As businesses transport enormous amounts of goods within and among states, the nation's economy becomes more connected. Nationally, about 62 percent of the value and 35 percent of the weight of shipments by all modes were interstate. These estimates from the CFS show the national dimensions of freight movement within the United States.

International Trends in Passenger Mobility and Freight Activity

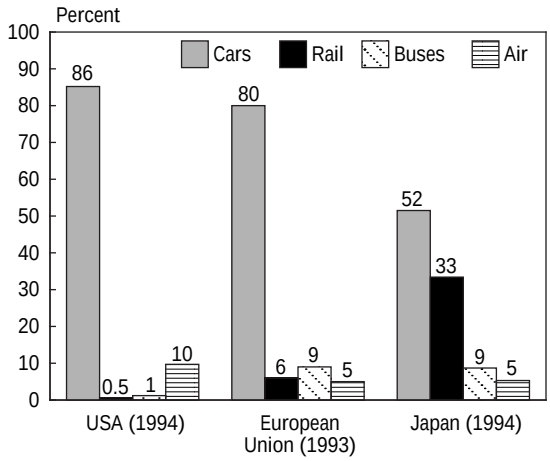
Americans traveled more than 24,000 passenger-kilometers (pkm) per capita in 1991, surpassing Europeans at 12,000 pkm and Japanese at 11,000 pkm. The United States also leads all countries in freight intensity with almost 20,000 metric ton-kilometers per capita in 1994 compared with 10,000 in Canada and about 4,500 in Japan.

As national economies and real personal income increase in most parts of the world, passenger cars and trucks are replacing rail and bus service and nonmotorized transportation for both passenger travel and freight activity. Air transportation is generally the fastest growing mode (but it holds a small overall modal share). Although changes in passenger travel and freight movement are evident in all regions of the developing world except some parts of Africa, the pace and extent of change varies greatly.

In the United States, cars and light trucks dominate passenger travel, accounting for 86 percent of passenger-miles traveled in 1994. Passenger cars account for about 80 percent of pkm in Western Europe. In Japan, by contrast, only about half of travel takes place in passenger cars, in part reflecting the importance of intercity and urban rail services in the high-population-density corridor between Tokyo and Osaka.

The number of passenger cars in use has been growing faster than the population in the developed countries. Automobile growth, however, is the highest in some developing countries, especially the rapidly growing economies in Asia.

Passenger-Kilometers Traveled by Mode



SOURCE: See figure 10-1 in chapter 10.

The United States still has the greatest number of cars, both absolutely and per capita.

Increasing income is a key factor influencing the shift toward cars. Other important factors include household formation, women's participation in the workforce, population age distribution, and shifts taking place in workplace locations. In developed countries, people tend to be moving out of urban areas to the suburbs. In developing countries, people tend to be moving from rural to urban areas, concentrating in the urban periphery.

The increased use of motor vehicles has resulted in greater personal mobility and freight activity, as well as in congestion, pollution, and higher energy consumption. Due in large part to increasing automobile use, cities such as Bangkok and Mexico City are facing urgent air pollution and congestion problems. Because of these problems, some countries have focused attention on how to stem the rise of personal automobile use, while enhancing public forms of transportation.

A nation's domestic freight activity generally increases in step with economic growth. Annual growth in freight activity in OECD countries has been between 1 percent and 4 percent during the last two decades, but over 7 percent in such rapidly growing countries as China. While U.S. freight activity has been growing at just 2 percent annually, per-capita U.S. freight activity is 10 times the 2,000 metric ton-kilometers generated per capita in China. Freight activity has been relatively constant in countries of the former East Bloc, where economies have been stagnant.

Trucks have been moving a greater share of freight, while the rail share has been declining, but with a worldwide average of 7.5 percent growth per year, air freight has been the fastest growing mode. Still, in most countries, air has a significantly smaller share of freight activity than either truck or rail.

The general shift from rail to motor vehicles and, now, air transportation for freight reflects structural, business production, and technology changes. For example, road and air transportation are more viable in countries where manufacturing and services are major economic sectors compared with agriculture or mining. Compared with rail, trucking provides more flexibility for just-in-time manufacturing.

Nonetheless, there are notable differences among countries in freight modal trends. In the United States, all freight modes increased their ton-miles of transportation between 1970 and 1994 (see chapter 9). In western Europe as a whole, by contrast, rail freight activity (measured in metric ton-kilometers) declined an average of 0.4 percent annually over the period. Concern about the growing dominance of road transportation has prompted some European countries and the European Union to seek ways to promote rail, inland watercarriage, and intermodalism.

Mobility and Access in the Information Age

Information technologies have become an important element of transportation. As a motivator and enabler of innovation, IT may ultimately have an impact on the performance and use of the transportation system comparable to the impacts of earlier advances in propulsion systems. IT applications not only can be used to improve operation, control, and management of the physical elements of transportation, but also can improve organizational processes used in transportation.

Information technologies are being adopted throughout the economy in ways that are fundamentally affecting not only the supply of new services, but also the nature of society's needs and desires for mobility and access. Today, people in many places around the world can choose among fax, electronic mail, and overnight

express for the movement of documents, or avoid intercity trips through conference calls. Such options are affecting commercial operations and daily life.

Transportation-related enterprises, like most businesses, are being changed by IT. The "bottom line" in transportation applications of IT is determined by the balance between cost and service. IT can affect both strongly. The acquisition and processing of operational, financial, and related data directly support higher system capacity, greater labor and capital productivity, improved efficiency, more effective resource allocation, and better integration of the many processes and activities that cumulatively produce transportation services.

Detailed understanding of system operations enables the design and implementation of innovative operational concepts and practices. The overnight package delivery service, for example, could hardly exist on its present scale without a myriad of computers, digital tags on each item, and extensive communications links. Similarly, computerized reservation systems are critical to the operation of the commercial aviation system, which fills well over 1 million airline seats each day for several thousand origin-destination pairs at market-driven prices.

Information technologies are beginning to transform the interface between the service provider and the customer or user. The implementation of intelligent transportation systems (ITS) includes as a basic component the provision of real-time status information for local highways and transit systems, potentially with guidance as to optimal choices for particular trips. An individual sending a package for next-day delivery can use the Internet to track its progress. With a highly controlled and visible transportation system, manufacturers can safely integrate their suppliers into just-in-time production systems and tailor their outputs to short-term customer needs.

Information technologies also can alter the need to travel, or the type of transportation consumed. Personal purchases may be made by traveling to a store, or by ordering (using the telephone or the Internet) and relying on a delivery service. Aided by modem-equipped computers, fax machines, and online services, some people find it feasible—and often preferable—to work from home, either as a telecommuting employee or as an independent business or contractor.

Most transportation uses of IT depend on the integration of many specific technologies and capabilities. Improvements in one technical area may make new applications or services available. The full impact of the IT evolution for transportation is likely to emerge slowly in the coming decades, and often will not be separable from the effects of other societal changes.

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BTS has published a companion volume to this report, *National Transportation Statistics 1997* (NTS), which covers the 1960 through 1995 time period. NTS provides modal profiles and statistics on the state of transportation, the economic importance of transportation, safety trends, and energy and environmental aspects of transportation. Most of the NTS tables, as well as many other BTS products, are available on the BTS Internet homepage. Information about contacting BTS is on the back cover of this report.

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